Advanced Colloids Experiments (ACE)

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Engineering Team: ZIN Technologies, Inc.

Glenn Research Center

Objective:

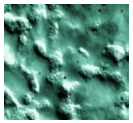
- To remove gravitational jamming and sedimentation so that it is possible to observe how order arises out of disorder and to learn to control this process. Small colloidal particles can be used to model atomic systems and to engineer new systems. Colloids are big enough (in comparison to atoms) to be seen and big enough and consequently slow enough that their evolution can be recorded with a camera. With a confocal microscope, templates, and grids, we can observe this process in 3-d and learn to control it.

Relevance/Impact:

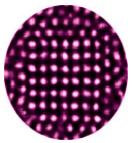
- Understanding phase separation without the effects of gravity reveals how to extend product shelf-life. This is a multi-billion $ concern for P&G. (Lynch, P&G Principal Scientist works directly with NASA through a Space Act Agreement)
- Recently developed technologies make it possible to do colloidal engineering in microgravity. Scientists can now see how structures form. (Weitz, Harvard)
- The technology exists to create lock-and-key self-replicating non-biological structures from nanoscale building blocks in microgravity using colloidal self-assembly. (Chaikin, NYU)
- With temperature sensitive polymers and microgels, the processes of repeatable melting and crystallization can be observed in 3-d at the level of the individual particles with these model “atomic” systems. (Yodh, Penn)
- This work will be done in collaboration with the European scientists (PIs) listed above.

Development Approach:

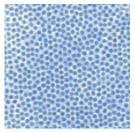
- The Advanced LMM-Colloids flight experiment will use the existing Light Microscopy Module (LMM) hardware in the Fluids Integrated Rack (FIR) aboard the International Space Station (ISS), along with confocal microscopy.
- Optimizing the SRD to maximize the science return of LMM.
- Preliminary-ACE (PACE) test of high resolution (50x and above) capabilities using real biological and colloidal samples this year (2010). ACE-1 begins full-scale science with the microscope in 2012; and with 3d confocal capabilities ready for use in 2014.



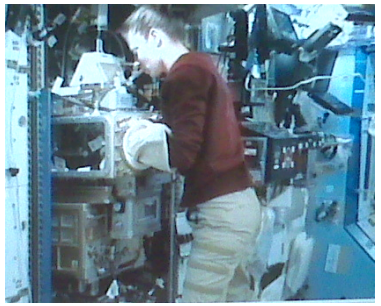
Weitz: Colloidal engineering



Chaikin: Order and patterns



Yodh: Melting and crystallization



Astronaut Tracy Caldwell performing LMM operations April 16, 2010.

ISS Resource Requirements

Accommodation (carrier)	Fluids Integrated Rack (FIR)/LMM
Upmass (kg) (w/o packing factor)	225 Kg for LMM-Colloids
Volume (m^3) (w/o packing factor)	0.09 LMM-Colloids
Power (kw) (peak)	0.5kw for LMM-Colloids 1.1 kw for FIR / LMM-Colloids
Crew Time (hrs) (installation/operations)	14 Hours (320 hrs unattended)
Autonomous Operation	2wks/module 5 modules = 10 wks
Launch/Increment	2010 PACE /2011 ACE-1/ 2014 ACE

Project Life Cycle Schedule

Milestones	Delta SCR	RDR	PDR/CDR	VRR	Safety	FHA	Launch	Ops	Return	Final Report
ACE Confocal	8/2010	2/2011	8/2011	2/2012	Phase III 2013	2013	2014	Inc. 32-35	2015	2016
ACE-1	8/2010	8/2010	3/2011	N/A	2011	2011	1/2012	Inc. 29-31		

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